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IS/IEC 61241-11 (2005): Electrical apparatus for use in the presence of combustible dust, Part 11: Protection by intrinsic safety 'ID' [ETD 22: Electrical Apparatus for Explosive Atmosphere]

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भाग 11 इंट्रिन्सिक सुरक्षा ‘iD’ द्वारा सुरक्षा

Indian Standard

ELECTRICAL APPARATUS FOR USE IN THE PRESENCE OF COMBUSTIBLE DUST

PART 11 PROTECTION BY INTRINSIC SAFETY 'iD'

ICS 29.260.20

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BUREAU OF INDIAN STANDARDS
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Electrical Apparatus for Explosive Atmospheres Sectional Committee, ETD 22

NATIONAL FOREWORD

This Indian Standard (Part 11) which is identical with IEC 61241 -11:2005 "Electrical apparatus for use in the presence of combustible dust — Part 11: Protection by intrinsic safety ID*" issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Apparatus for Explosive Atmospheres Sectional Committee and approval of the Electrotechnical Division Council.

The contents of Corrigendum 1 to IEC 61241-11 issued by IEC in 2006 are included in this standard.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60079-0 Electrical apparatus for potentially explosive atmospheres — Part 0: General requirements	IS/IEC 60079-0 : 2004 Electrical apparatus for explosive gas atmospheres: Part 0 General requirements	Technically Equivalent
IEC 60079-11 Electrical apparatus for explosive gas atmospheres—Part 11: Intrinsic safety T	IS 5780:2002 Electrical apparatus for explosive gas atmospheres — Intrinsic safety *T* — Specification *{second revision)*	do
IEC 60079-25 Electricai apparatus for explosive gas atmospheres — Part 25: Intrinsically safe systems	IS/IEC 60079-25 : 2003 Explosive atmospheres: Part 25 Intrinsically safe systems	do
IEC 60529:1989 Degrees of protection provided by enclosures (IP code)	IS 12063 : 1987 Classification of degrees of protection provided by enclosures of electrical equipment	
IEC 61241-0 Electrical apparatus for use in the presence of combustible dust — Part 0: General requirements	IS/IEC 61241-0 : 2004 Electrical apparatus for use in the presence of combustible dust: Part 0 General requirements	**do**
IEC 61241-1 Electrical apparatus for use in the presence of combustible dust — Part 1: Protection by enclosures "tD"	IS/IEC 61241-1 : 2004 Electrical apparatus for use in the presence of combustible dust: Part 1 Protection by enclosures "tD"	do

Only the English language text has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in the IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this Standard.

INTRODUCTION

Many dusts which are generated, processed, handled and stored, are combustible. When ignited they can burn rapidly and with considerable explosive force if mixed with air in the appropriate proportions. It is often necessary to use electrical apparatus in locations where such combustible materials are present, and suitable precautions must therefore be taken to ensure that all such apparatus is adequately protected so as to reduce the likelihood of ignition of the external explosive atmosphere. In electrical apparatus, potential ignition sources include electrical arcs and sparks, hot surfaces and frictional sparks.

Areas where dusts, flyings and fibres in air occur in dangerous quantities are classified as hazardous and are divided into three zones according to the level of risk.

Generally, electrical safety is ensured by the implementation of one of two considerations, i.e. that electrical apparatus be located where reasonably practicable outside hazardous areas and that electrical apparatus be designed, installed and maintained in accordance with measures recommended for the area in which the apparatus is located.

Combustible dust can be ignited by electrical apparatus in several main ways:

- by surfaces of the apparatus that are above the minimum ignition temperature of the dust concerned. The temperature at which a type of dust ignites is a function of the properties of the dust, whether the dust is in a cloud or layer, the thickness of the layer and the geometry of the heat source;
- by arcing or sparking of electrical parts such as switches, contacts, commutators, brushes, or the like;
- by discharge of an accumulated electrostatic charge;
- by radiated energy (e.g. electromagnetic radiation);
- by mechanical sparking or frictional sparking or heating associated with the apparatus.

In order to avoid ignition hazards it is necessary that:

- the temperature of surfaces, on which dust can be deposited, or which would be in contact with a dust cloud, is kept below the temperature limitation specified in this standard;
- any electrical sparking parts, or parts having a temperature above the temperature limit specified in IEC 61241-14
  - are contained in an enclosure which adequately prevents the ingress of dust, or
  - the energy of electrical circuits is limited so as to avoid arcs, sparks or temperatures capable to ignite combustible dust;
- any other ignition sources are avoided.

Several techniques are available for explosion protection of electrical apparatus in hazardous areas. This standard describes the safety features of this type of explosion-protection technique and specifies the requirements to be adopted. It is most important that the correct selection and installation procedures be followed to ensure the safe use of electrical apparatus in hazardous areas.

Compliance with this part of I EC 61241 will only provide the required level of safety if the electrical apparatus is operated within its rating and is installed and maintained according to the relevant codes of practice or requirements, for example in respect of protection against over-currents, internal short-circuits, and other electrical faults, in particular, it is essential that the severity and duration of an internal or external fault be limited to values that can be sustained by the electrical apparatus without damage$_t$ for example, installed in a system designed in accordance with the principles of I EC 60079-25 and installed in accordance with IEC 61241-14.

The following principles should be followed:

- the electronic circuits must fulfil Group IIB requirements according to IEC 60079-11 to avoid spark ignition;
- IP 6X or encapsulation is normally required to ensure that creepage and clearance distances are not compromised by dust. Therefore the importance and the durability of the integrity of the enclosure or encapsulation are much higher than required by IEC 60079-11;
- There should be power limitation for apparatus or parts of apparatus not protected by an enclosure or encapsulation (e.g. uninsulated sensor) to avoid ignition of a dust layer by power dissipation directly into the dust (power matching by conductive dusts) and to avoid thermal ignition on the surface of components;
- limitation of the temperature of all exposed surfaces of all apparatus or parts of apparatus exceeding the power limitation limits in accordance with IEC 61241-0. The surface can be the surface of the enclosure or of the encapsulation.

Indian Standard

ELECTRICAL APPARATUS FOR USE IN THE PRESENCE OF COMBUSTIBLE DUST

PART 11 PROTECTION BY INTRINSIC SAFETY 'ID'

1 Scope

This part of IEC 61241 specifies requirements for the construction and testing of intrinsically safe apparatus intended for use in potentially explosive dust cloud or dust layer environments and for associated apparatus that is intended for connection to intrinsically safe circuits which enter such environments.

This standard supplements the general requirements of IEC 61241-0: except as indicated in the following list.

Apparatus utilized in systems will meet the requirements of IEC 60079-25.
If associated apparatus is protected by a type of protection listed in IEC 61241-0 or IEC 60079-0 then the requirements of that method of protection together with the relevant parts of IEC 61241 or IEC 60079 also apply to the associated apparatus. The list of exclusions which follows is directly applicable to associated apparatus intended for use in situations where there is no potentially hazardous atmosphere and in other circumstances should be used in combination with the requirements of the other methods of protection.

Clause or subclause of IEC 61241-0		**Intrinsically safe apparatus**	**Associated apparatus**
4.1	General	Applies	Applies
4.2	Principles for design and testing of apparatus for use in Zone 20	Applies	Excluded
4.3	Opening enclosures	Applies	Excluded
4.4	Environmental conditions	Applies	Excluded
5.1	Maximum surface temperature	Applies	Excluded
5.2	Maximum surface temperature with respect to dust layers above 50 mm	Applies	Excluded
S.3	Ambient temperature	Applies	Applies
6.1	Non-metallic enclosures and non-metallic parts of enclosures	Applies	Excluded
6.1.1	Material specification	Applies	Excluded
6.1.2	Plastic materials	Applies	Excluded
6.1.3	Verification of compliance	Applies	Excluded
6.1.4	Thermal endurance	Applies	Excluded
6.1.5	Electrostatic charges	Applies	Excluded
6.2	Enclosures containing light metals	Applies	Excluded
6.2.1	Composition	Applies	Excluded
6.2.2	Threaded holes	Excluded	Excluded
7	Fasteners	Excluded	Excluded
8	Interlocking devices	Excluded	Excluded
9	Bushings	Excluded	Excluded

Clause or subclause of IEC 61241-0		Intrinsically safe apparatus	Associated apparatus
10	Materials used for cementing	Applies	Excluded
11	Ex components	Applies	Excluded
12	Connection facilities and terminal	Excluded	Excluded
13	Connection facilities for earthing or bonding conductors	Excluded	Excluded
14	Cable and conduit entries	Applies	Excluded
15	Radiating equipment	Applies	Excluded
16	Rotating electrical machines	Excluded	Excluded
17	Switchgear	Excluded	Excluded
18	Fuses	Excluded	Excluded
19	Plugs and sockets	Excluded	Excluded
20	luminaires	Excluded	Excluded
21	Caplights, caplamps and handlamps	Excluded	Excluded
22	Apparatus incorporating cells and	Applies	Excluded
23.1 to 23.3	Verification and tests	Applies	Applies
23.4.1	General	Applies	Excluded
23.4.2.1	Test for resistance to impact	Applies	Excluded
23.4.22	Drop test	Applies	Excluded
23.4.2.3	Verification *	Applies	Excluded
23.4.3	Test for dust exclusion (degree of	Applies	Excluded
23.4.4	Torque test for bushings in enclosures for use in	Excluded	Excluded
23.4.5.1	Measurement for maximum surface	Applies	Excluded
23.4.5.2	Measurement for surface temperature under excess layer	Applies	Excluded
23.4.5.3	Temperature control	Applies	Excluded
23.4.6	Thermal shock tests	Applies	Excluded
23.4.7.1 to 23.4.7.5	Tests of non-metallic enclosures or of non-metallic parts of apparatus for use in Zone 20 or 21	Excluded	Excluded
23.4.7.6	Mechanical tests	Applies	Excluded
23.4.7.7	Surface resistivity test	Applies	Excluded
27	Clamping tests of cable entries for non-armoured	Excluded	Excluded
28	Clamping tests of cable entries for armoured	Excluded	Excluded
29	Marking	Applies	Applies
30	Examples of marking	Applies	Applies
8 IEC 61241-0 pass criteria apply.			

This part of IEC 61241 is applicable to electrical apparatus in which the electrical circuits themselves are incapable of causing an explosion in the surrounding combustible dust environment. In other circumstances, associated apparatus should be used in combination with the requirements of the other methods of protection listed in IEC 61241-0.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

(EC 60079-0, *Electrical apparatus for potentially explosive atmospheres - Part 0: General requirements*

IEC 60079-11, *Electrical apparatus for explosive gas atmospheres - Part 11: Intrinsic safety T*

IEC 60079-25, *Electrical apparatus for explosive gas atmospheres - Part 25: Intrinsically safe systems*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

!EC 61241-0, *Electrical apparatus for use in the presence of combustible dust - Part 0: General requirements*

IEC 61241-1, *Electrical apparatus for use in the presence of combustible dust - Part 1: Protection by enclosures "tb"*

3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 61241-0, IEC 60079-0 and IEC 60079-11 apply except that where the term "explosive gas atmosphere" is used it shall be interpreted as meaning "combustible dust environment".

4 Grouping and classification of intrinsically safe apparatus and associated apparatus

intrinsically safe apparatus and associated apparatus shall be grouped and classified in accordance with IEC 61241-0.

5 Categories of electrical apparatus

Clause 5 of IEC 60079-11 applies together with the following requirement:

Apparatus shall, at a minimum, meet the spark ignition energy level requirements for Group IIB apparatus.

6 Apparatus construction

6.1 Enclosures

In principle, intrinsically safe apparatus does not need an enclosure as the method of protection is embodied within the circuits. However, where intrinsic safety can be impaired by access to conducting parts, for example if dust of any type can bridge infallible creepage distances, an enclosure of at least IP6x in accordance with IEC 60529 and as required by I EC 61241-1 shall be provided. In all other circumstances, the degree of protection provided by the enclosure that is required will vary according to the intended purpose of the apparatus. **Parts** of apparatus not within an enclosure having a degree of protection of at least IP6x that are encapsulated to a depth of at least 1 mm shall be considered to be adequately protected against dust contamination. Where parts of a circuit are not protected by an enclosure or encapsulation as indicated, for example uninsulated sensor circuits in direct contact with the explosive dust atmosphere, they shall be assessed or tested in accordance with this standard assuming that all spacings do not meet the creepage and clearance requirements of 6.4.

The enclosure construction and/or the encapsulation shall be recorded in the definitive documentation { see Clause 13).

6.2 Temperatures of apparatus immersed in dust

6.2.1 General

Whenever possible intrinsically safe apparatus for dusts should be enclosed. This clause applies to such apparatus as temperature sensors or parts of measuring devices which cannot be enclosed and are intended for immersion in a dust. All temperatures shall be measured or assessed under the most onerous fault conditions in this standard but without applying factors of safety to the current, voltage or power. The following requirements are applicable to apparatus used with dusts having a minimum ignition temperature for a 5 mm layer of not less than 210 °C.

For potentiometers, the surface to be considered shall be that of the resistance element and not the external surface of the component. The mounting arrangement and heat-sinking and cooling effect of the overall potentiometer construction shall be taken into consideration during the test. Temperature shall be measured on the track with that current which flows under conditions of "iaD" or "ibD" as appropriate. If this results in a resistance value of less than 10 % of the track resistance value, the measurement shall be carried out at 10 % of the track resistance value.

6.2.2 Apparatus and component temperature

Apparatus is considered suitable for total immersion, or being subjected to an uncontrolled layer of such dust, if it conforms to one of the following:

a) the matched power dissipation in any component shall be in accordance with Table 1.

Table 1 - Permitted dissipation within a component

Maximum ambient temperature	°C	40	70	100
Permitted dissipation	mW	750	650	550

b) Where intrinsically safe electrical circuits are exposed to, or directly immersed in a flammable dust with a dust layer smouldering temperature greater than 200 °C, no testing of temperature rise is required provided that at the point of contact the available power is less than 750 mW and the short-circuit current is less than 250 mA.

c) The apparatus shall satisfactorily comply with the standardized dust immersion test specified in 6.2.3. Apparatus which complies shall be considered as suitable for use at the maximum stated ambient temperature with any combustible dust having an ignition temperature no lower than 210 °C.

6.2.3 Standardized dust immersion temperature test

This test and the associated requirements are under further consideration.

6.2.4 Wiring within apparatus

As for 6.2.2 of IEC 60079-11.

6.2.5 Printed circuit wiring

As for 6.2.3 of IEC 60079-11.

6.2.6 Unenclosed circuits

Circuits of intrinsically safe apparatus intended to be in direct contact with the explosive dust atmosphere shall be capable of meeting at feast the spark ignition requirements for Group MB apparatus, in this case, it shall be assumed that all spacings do not meet the creepage and clearance distance requirements specified in **6.4.**

6.3 Facilities for connection of external circuits

6.3.1 Terminals

As for 6.3.1 of IEC 60079-11

6.3.2 Plugs and sockets

As for 6.3.2 of IEC 60079-11

6.3.3 Determination of maximum external inductance to resistance ratio (Lo/Ro) for resistance limited power source

As for 6.3.3 of IEC 60079-11

6.3.4 Permanently connected cables

As for 6.3.4 of I EC 60079-11

6.4 Separation distances

As for 6.4 of IEC 60079-11

6.5 Protection against polarity reversal

As for 6.5 of I EC 60079-11

6.6 Earth conductors, connections and terminals

As for 6.6 of IEC 60079-11

6.7 Encapsulation used for exclusion of potentially explosive atmosphere

As for 6.7 of IEC 60079-11

7 Components on which intrinsic safety depends

7.1 Rating of components

As for 7.1 of IEC 60079-11

7.2 Connectors for internal connections, plug-in cards and components

As for 7.2 of IEC 60079-11

7.3 Fuses

As **for** 7.3 of IEC 60079-11

7.4 Primary and secondary cells and batteries

As for 7.4 of IEC 60079-11

7.5 Semiconductors

As for 7.5 of IEC 60079-11

7.6 Failure of components and connections

As for 7.6 of IEC 60079-11

7.7 Piezo-electric devices

As for 7.7 of IEC 60079-11

8 Infallible components, infallible assemblies of components and infallible connections

As for Clause 8 of IEC 60079-11 .

9 Diode safety barriers

As for Clause 9 of !EC 60079-11

10 Type verifications, assessments and type tests

10.1 Spark ignition assessment

If testing is required this should be in accordance with IEC 60079-11 using Group IIB gases.

10.2 Temperature tests

As for 10.5 of IEC 60079-11

10.3 Voltage tests

As for 10.6 of IEC 60079-11

10.4 Small component ignition test

As for 10.7 of IEC 60079-11

10.5 Determination of parameters of loosely specified components

As for 10.8 of IEC 60079-11

10.6 Tests for cells and batteries

As for 10.9 of IEC 60079-11

10.7 Mechanical test

10.7.1 Casting compound

A force of 30 N shall be applied perpendicular to the surface of the casting compound with a 6 mm diameter flat ended metal rod for 10 s. No damage to or permanent deformation of the encapsulation or movement greater than 1 mm shall occur.

Where a free surface of casting compound occurs, in order to ensure that the compound is rigid but not brittle, the following impact test shall be carried out on the surface of the casting compound at (20 ± 10) °C using the test apparatus described in Annex C of IEC 60079-0. For ail applications a minimum impact energy of 2 J shall be used.

The casting compound shall remain intact and no permanent deformation shall occur. Minor surface cracks shall be ignored.

10.7.2 Partitions

As for 10.10.2 of IEC 60079-11

10.8 Tests for apparatus containing piezoelectric devices

Measure both the capacitance of the device and also the voltage appearing across it when any part of the apparatus which is accessible in service is impact tested in accordance with the 'high' column of Table 4 in I EC 60079-0 carried out at (20±10)°C using the test apparatus in Annex D of IEC 60079-0. For the value of voltage, the higher figure of two tests on the same sample shall be used.

When the apparatus containing the piezoelectric device includes a guard to prevent a direct physical impact, the impact test shall be carried out on the guard with both it and the apparatus mounted as intended by the manufacturer.

The maximum energy stored by the capacitance of the crystal at the maximum measured voltage shall not exceed 0,25 mj. Where the electrical output of the piezoelectric device is limited by protective components (including guards), these components shall not be damaged by the impact in such a way as to allow the type of protection to be invalidated.

Where it is necessary to protect the apparatus from external physical impact in order to prevent the impact energy exceeding these values, details of the requirements shall be specified as special conditions for safe use and the apparatus shall be marked with an X.

10.9 Type tests for diode safety barriers and safety shunts

As for 10.12 of IEC 60079-11

10.10 Cable pull test

As-for 10.13 of IEC 60079-11

11 Routine verifications and tests

As for Clause 11 of IEC 60079-11

12 Marking

12.1 General

Intrinsically safe apparatus and associated apparatus shall carry at least the minimum marking specified in IEC 61241-0 and 12.2 of this standard. The marking of the serial number may be achieved by using a date or batch number code which is sufficient to ensure traceabiiity for quality control purposes.

NOTE 1 The serial number marking may be separate from the other marking.

For associated apparatus the symbol Ex iaD or Ex ibD (or iaD or ibD if Ex is already marked) shall be enclosed in square brackets.

All relevant parameters should be marked, e.g. U_m, Lj, Cj, L_0, C_0, wherever practicable.

NOTE 2 Standard symbols for marking and documentation are given in Clause 3 of IEC 60079-11.

Practical considerations may restrict or preclude the use of italic characters or of subscripts and a simplified presentation may be used, for example Uo rather than U_0.

12.2 Marking of connection facilities

Connection facilities, terminal boxes, plugs and sockets of intrinsically safe apparatus and associated apparatus shall be clearly marked and shall be clearly identifiable. Where a colour is used for this purpose, it shall be light blue.

Where parts of an apparatus or different pieces of apparatus are interconnected using plugs and sockets, these plugs and sockets shall be identified as containing only intrinsically safe circuits. Where a colour is used for this purpose it shall be light blue.

In addition, sufficient and adequate marking shall be provided to ensure correct connection for the continued intrinsic safety of the whole.

NOTE it may be necessary to include additional labels, e.g. on or adjacent to plugs and sockets, to achieve this. If clarity of intention is maintained the apparatus label may suffice.

The following are examples of marking:

a) Self-contained intrinsically safe apparatus

C TOME LTD
PAGING RECEIVER TYPE 3
Ex iaD 20 T135
-25 °C < Ta < + 50 °C
ACB Ex 01****
Serial No. xxxx

b) Intrinsically safe apparatus designed to be connected to other apparatus

M HULOT
TRANSDUCTEUR TYPE 12
Ex ibD 21 T135
ACB No. Ex01****
Li: 10uH   Ci: 1200pF
Ui: 28V   Ii: 250mA
Pi: 1,3 W

c) Associated apparatus

J SCHMIDT A.G.
STROMVERSORGUNG TYP 4
[Ex ibD]
ACB No: Ex01****
Um: 250 V   Po: 0.9 W
Io: 150 mA   Uo: 24 V
Lo: 14.2 mH   Co: 0.93uF

13 Documentation

As for Clause 13 of IEC 61241-0:2004.

in addition the documentation shall specify the maximum surface temperature of the apparatus and the conditions under which the temperature was determined. For example "maximum surface temperature 135 °C derived from the corn dust immersion temperature test of 6.2.3".

Where the apparatus is designed for use in a range of temperatures other than -20 °C to

+40 °C the permitted temperature range shall be specified in the documentation.

The category (iaD or ibD) shall also be specified.

Any other information necessary to ensure a safe use of the apparatus shall also be included.

Annex A
(normative)

See Annex B of IEC 60079-11

Annex B
(informative)

See Annex C of I EC 60079-11

Annex C
(normative)

See Annex D of IEC 60079-11

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